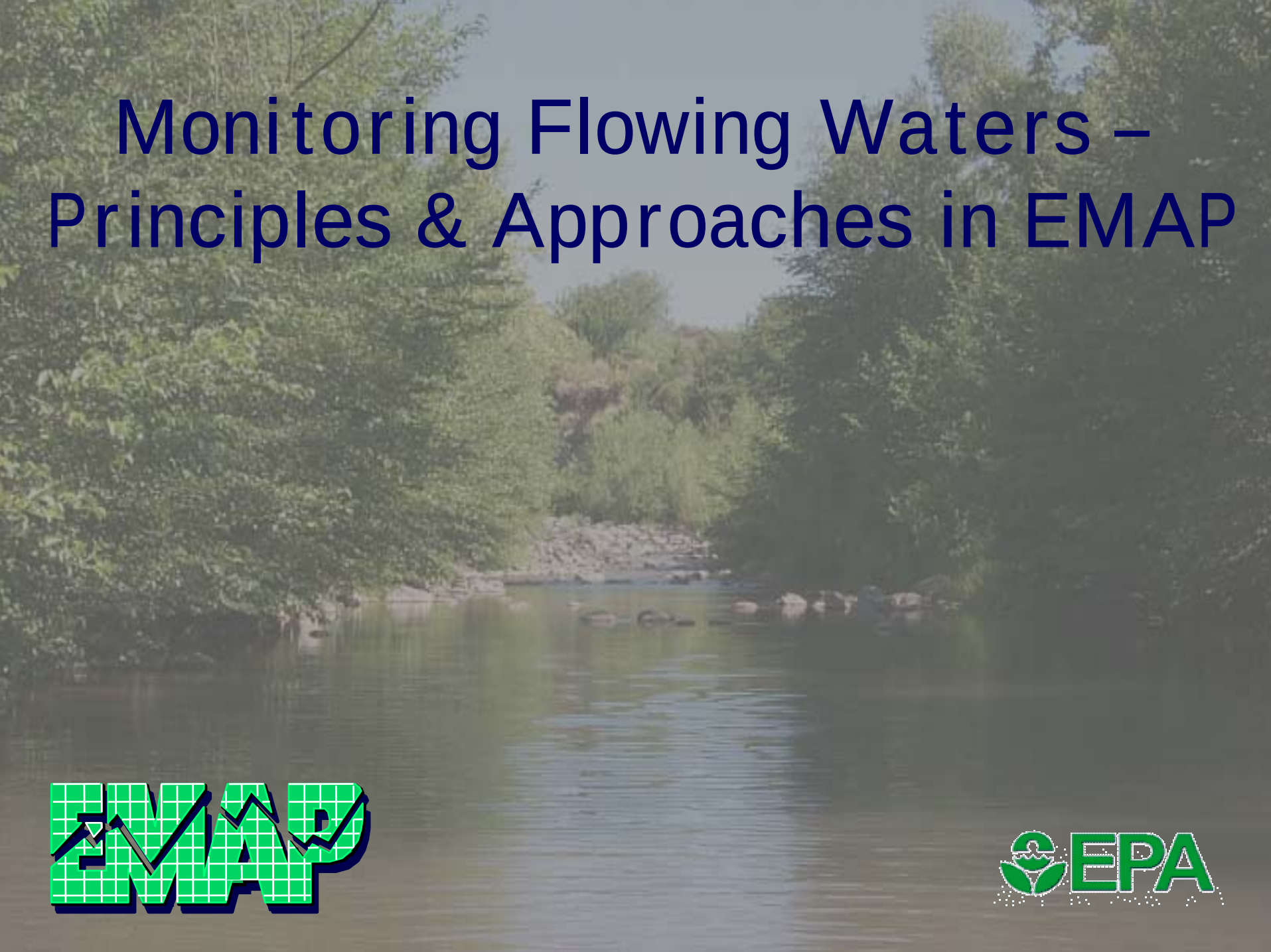
Monitoring Flowing Waters – Principles & Approaches in EMAP



EMAP Surface Waters Tools

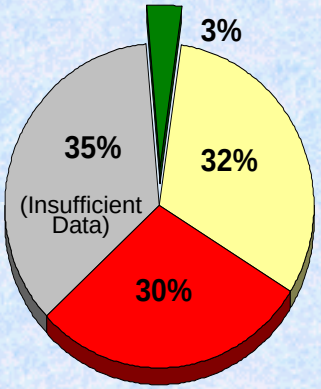
- Sample Survey Design
  - Spatially-balanced probability design
  - Results extrapolated to target population with known confidence
- Ecological Indicators
  - Biological Indicators
    - Direct measures of ecological condition
    - Societal value
  - Stressor Indicators
    - Associations with ecological condition
    - Relative importance
- Reference Condition
  - Consistent approach to setting expectations for all indicators
- Regional demonstrations
  - Regional implementation (e.g., EMAP-West)
  - Example Ecological Assessments

EMAP-West Assessment Questions

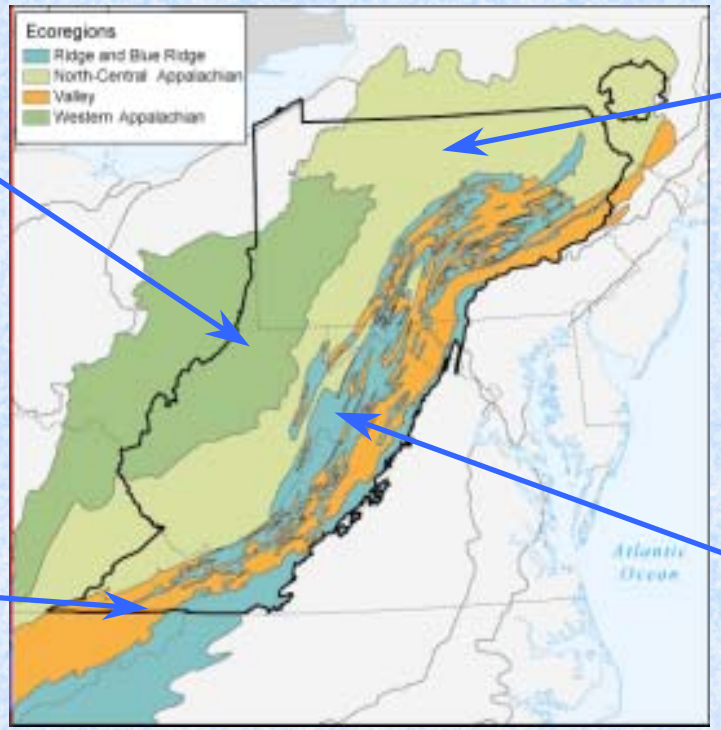
- **What proportion of stream and river length is in good ecological condition across the Western U.S.?**
  - **In each state?**
  - **In focused geographic areas within each Region?**
- What is the relative importance of stressors to stream ecological condition across the West?
  - In each state?
  - In focused geographic areas within each Region?

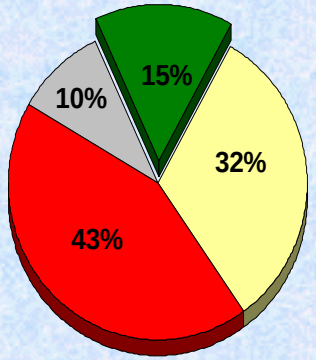
Example EMAP Assessment of Ecological Condition

Fish Index of Biotic Integrity
example from Mid-Atlantic
(90% CI = ± 10%)

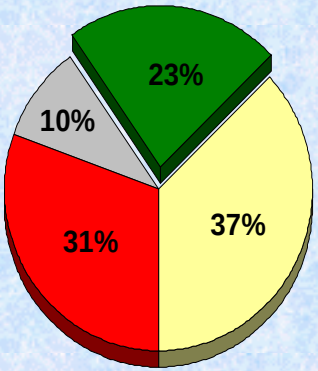


Western Appalachians

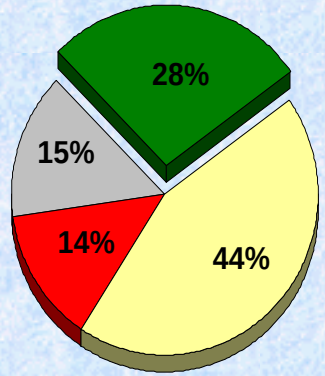




No.-Central Appalachians



Valleys



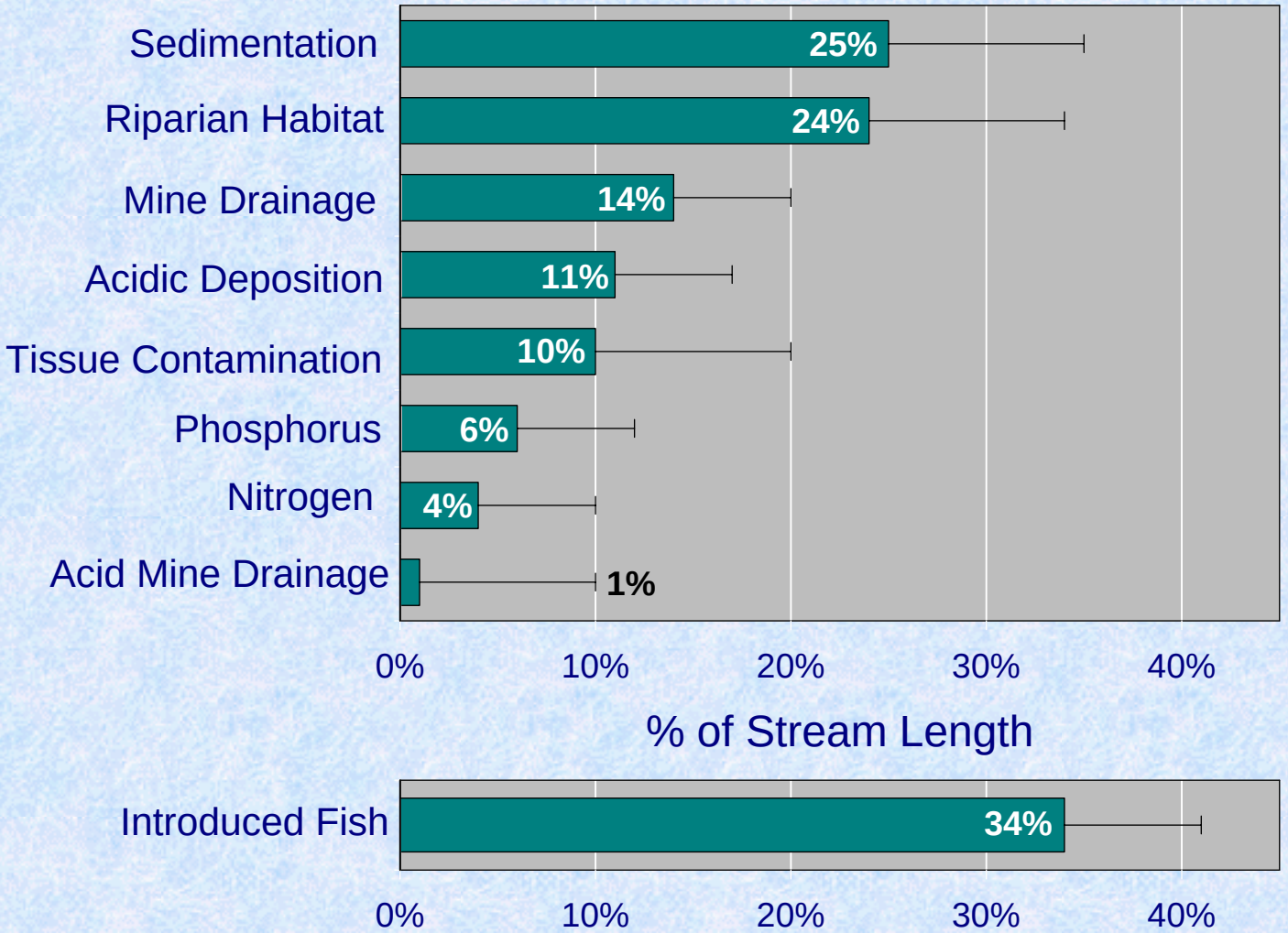
Ridge and Blue Ridge

EMAP-West Assessment Questions

- What proportion of stream and river length is in good ecological condition across the Western U.S.?
  - In each state?
  - In focused geographic areas within each Region?
- **What is the relative importance of stressors to stream ecological condition across the West?**
  - **In each state?**
  - **In focused geographic areas within each Region?**

Example EMAP Assessment - Ranking of Stressors

Stressor ranking example from Mid-Atlantic



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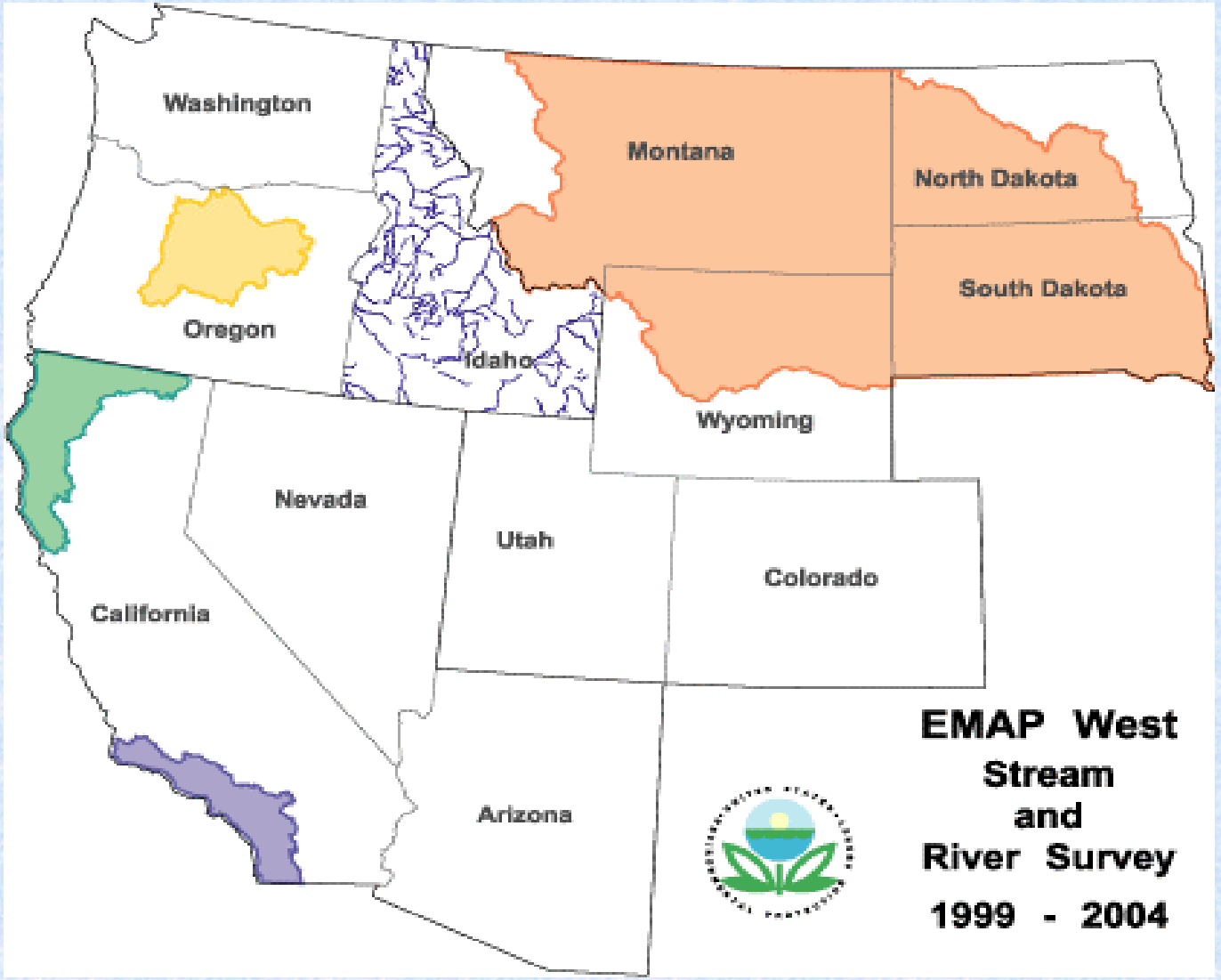
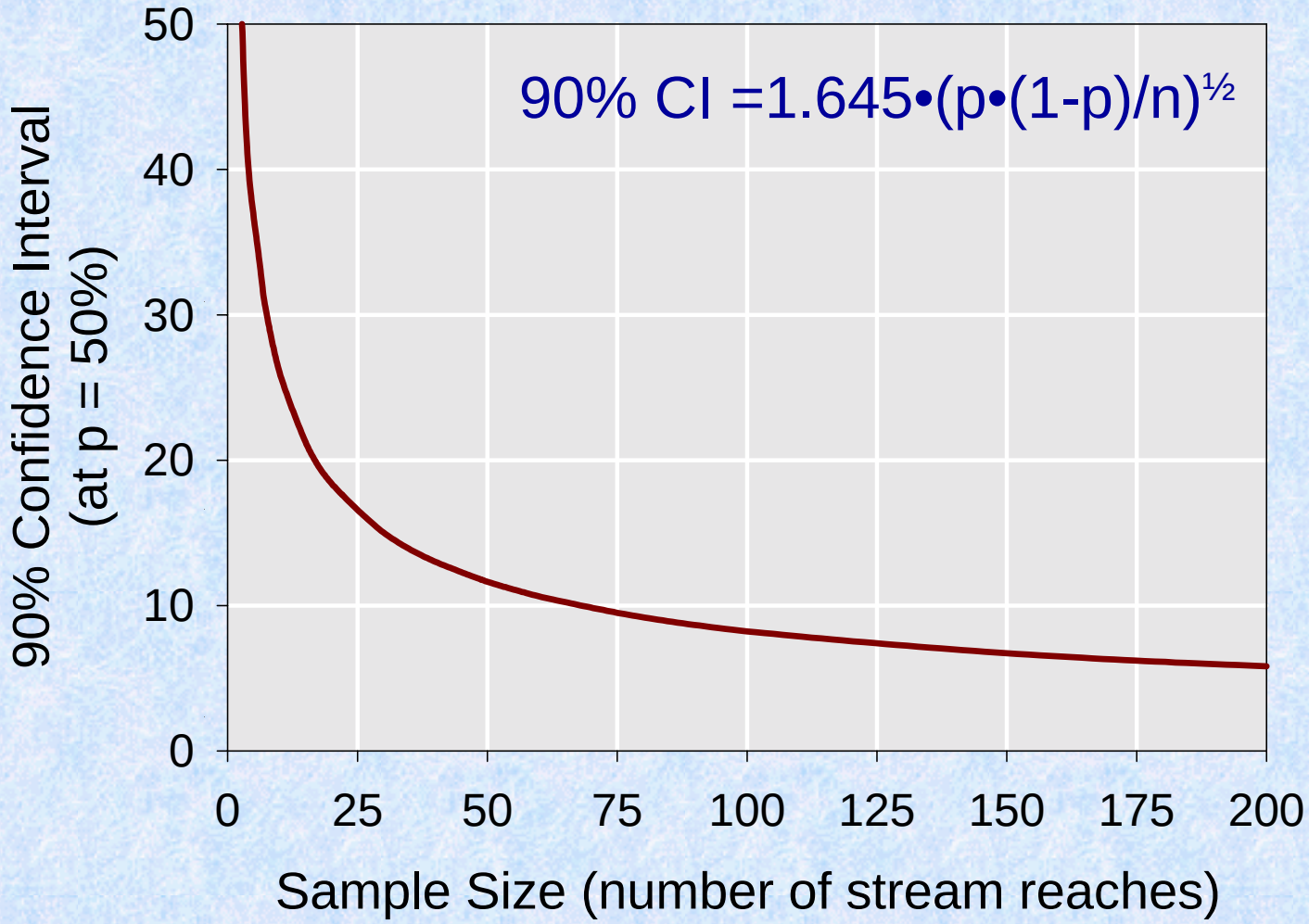
Sample Survey Design

Western Pilot



Sampling Uncertainty



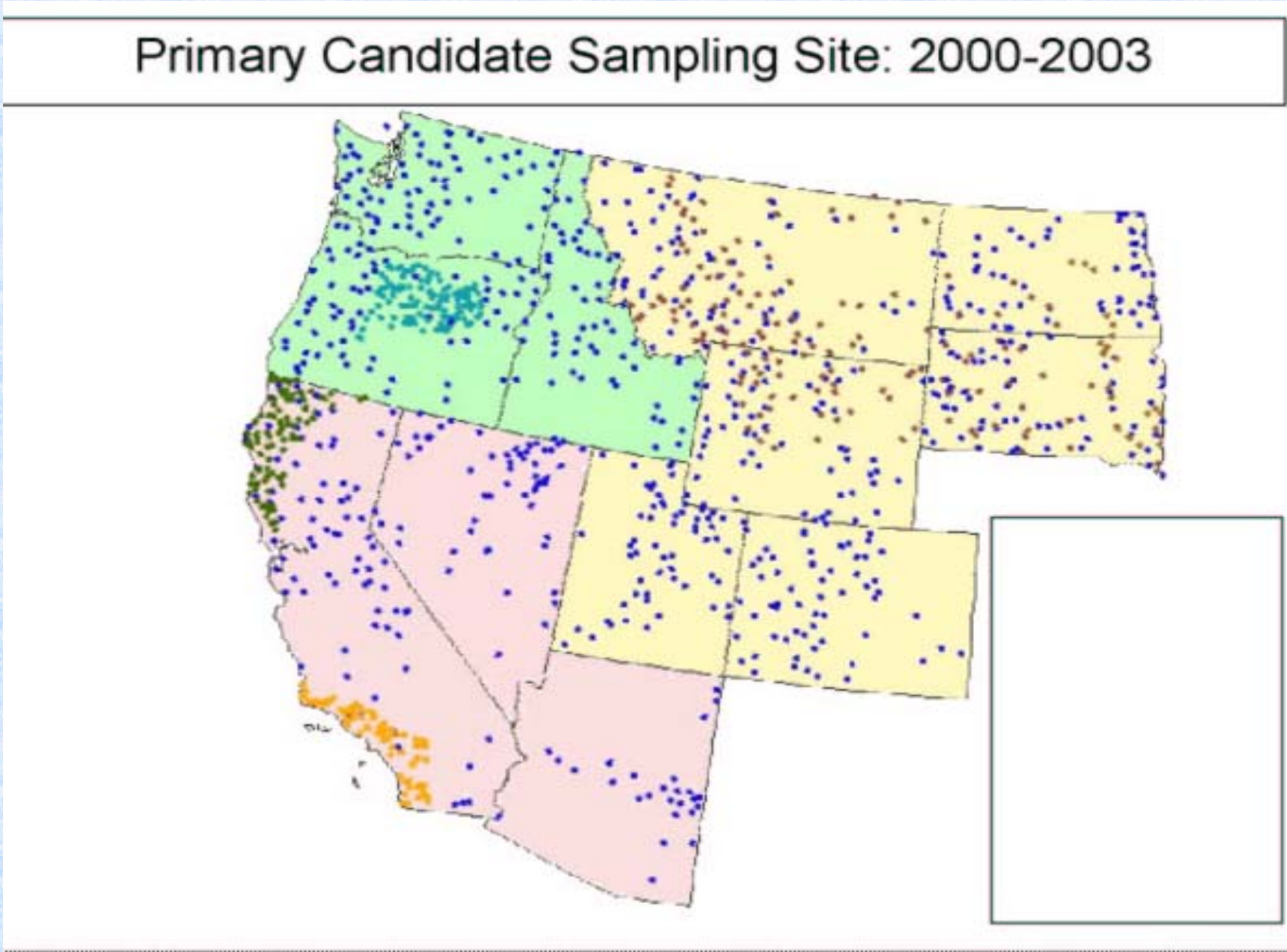
Spatial Reporting Units

- Design for these:
  - Western Region (1)
  - EPA Regions 8, 9, 10 (3)
  - Subregions of interest (6)
  - States (12)
- Post-stratify for these:
  - Stream type (...)
  - Ecoregion (...)
  - HUC (...)
  - Other?

EMAP-West Design

- Sample sizes:
  - 50 per State
  - Special study areas
    - 160: N. Calif, OR John Day, Missouri Basin
    - 80: S. Calif
    - 60: WA Wenatchee, ID Rivers,
- Unequal probability sample
  - 5 Strahler order categories: 1st, 2nd, 3rd, 4th+, large rivers
  - Arid and mountainous aggregated Omernik ecoregions

EMAP-West Design



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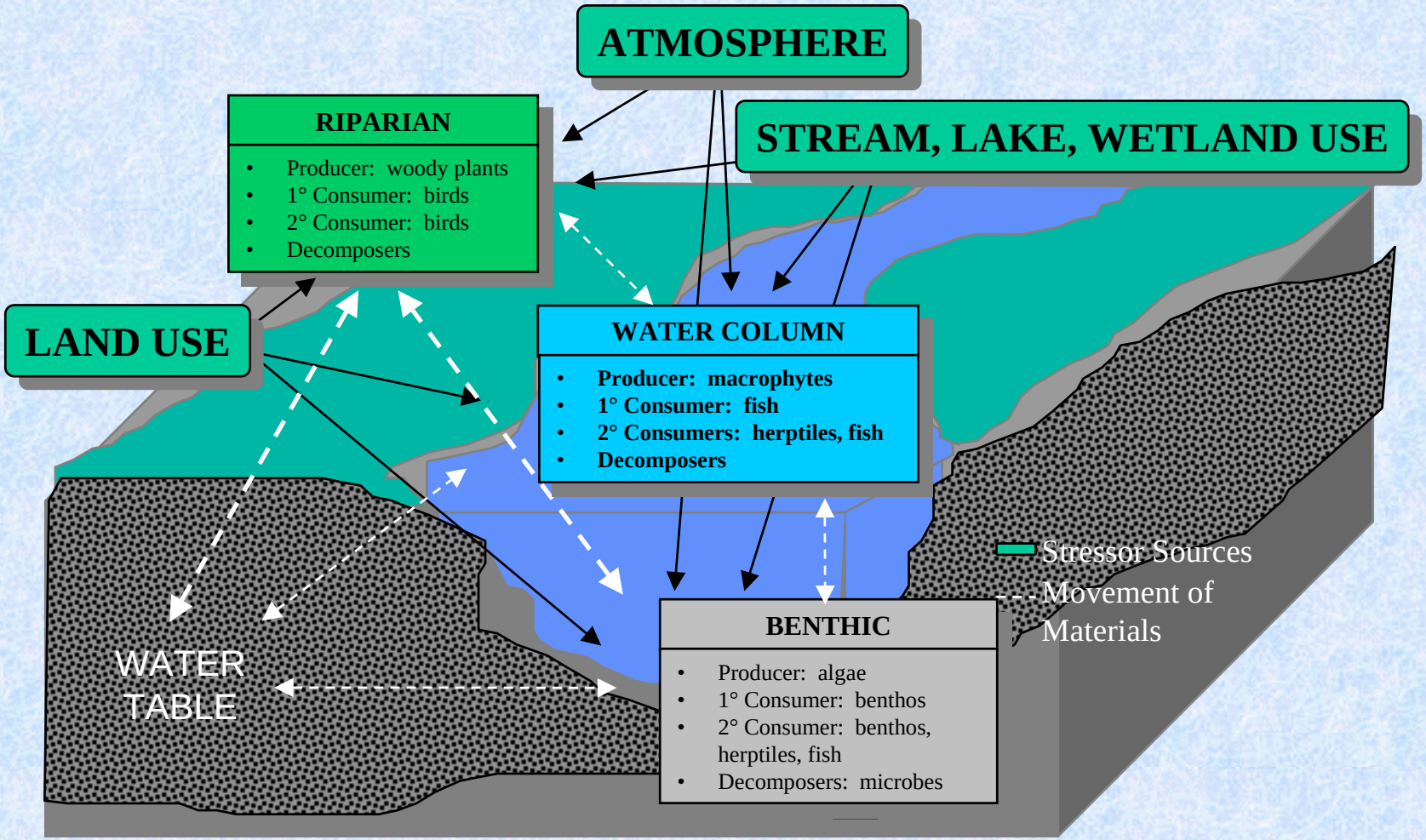
Indicator Approach

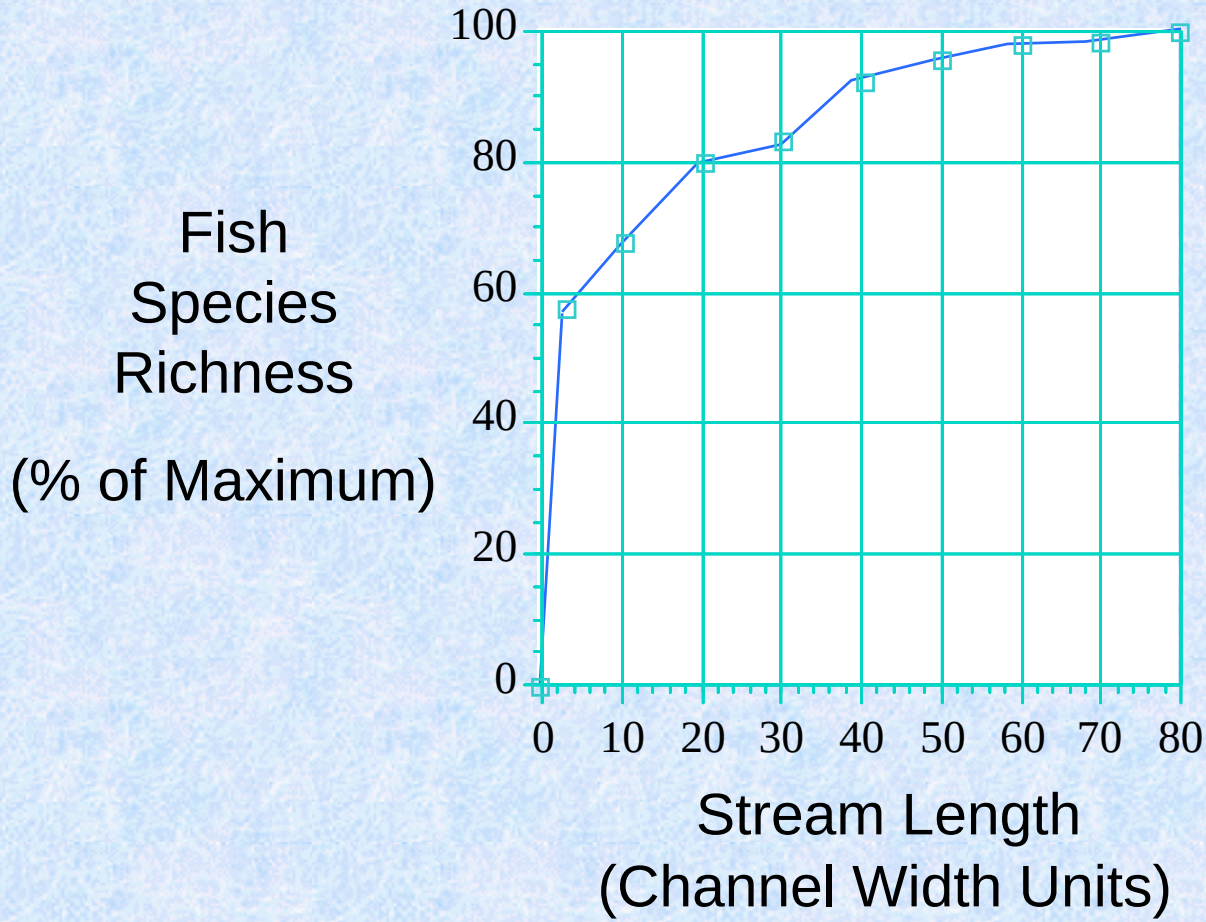
Indicator Criteria

- What can we (realistically) measure in a sample survey?
- How can we best measure it?
- How responsive is it?
- How variable is it?
- Can we score it?

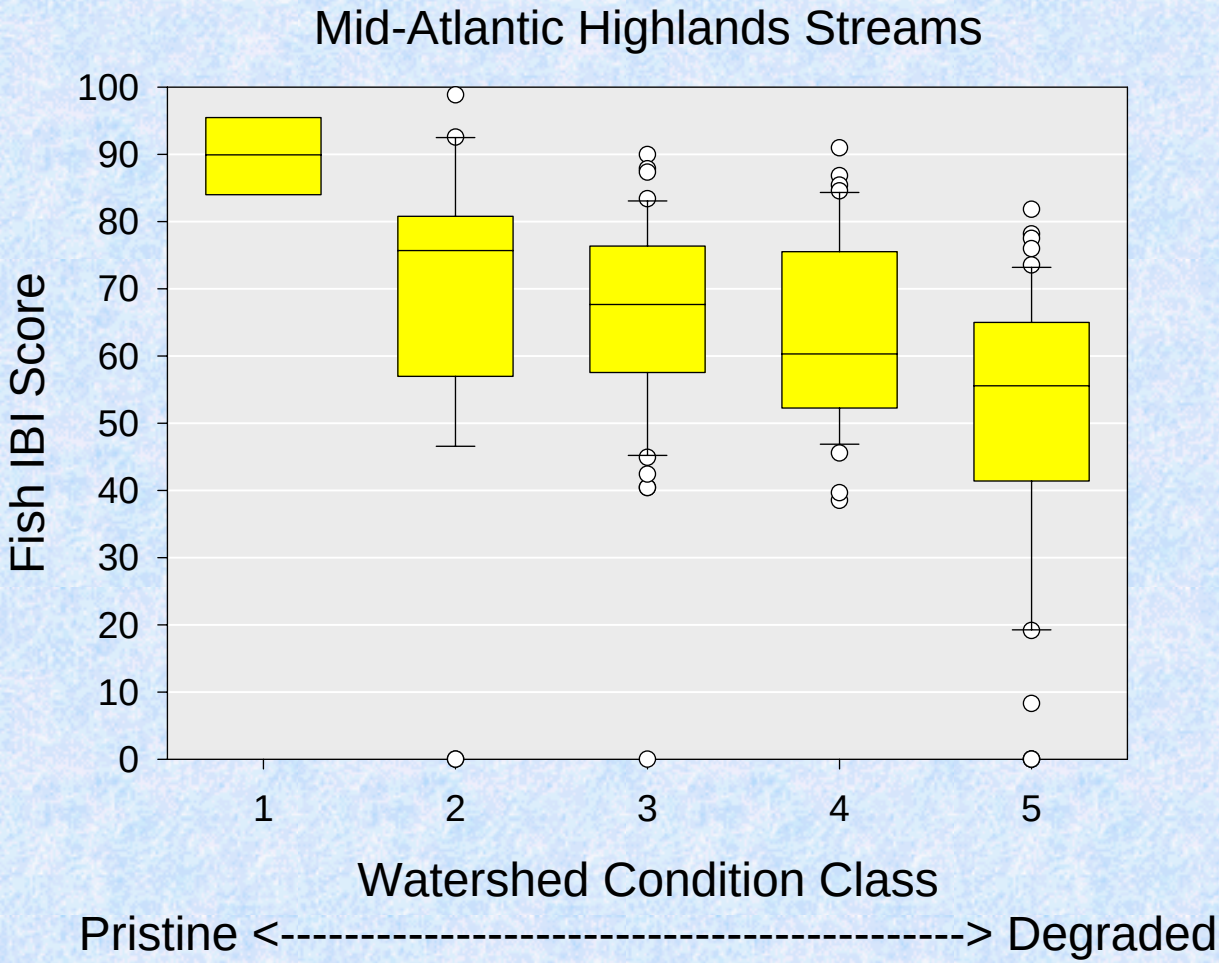
Indicator Approach
What we can measure?



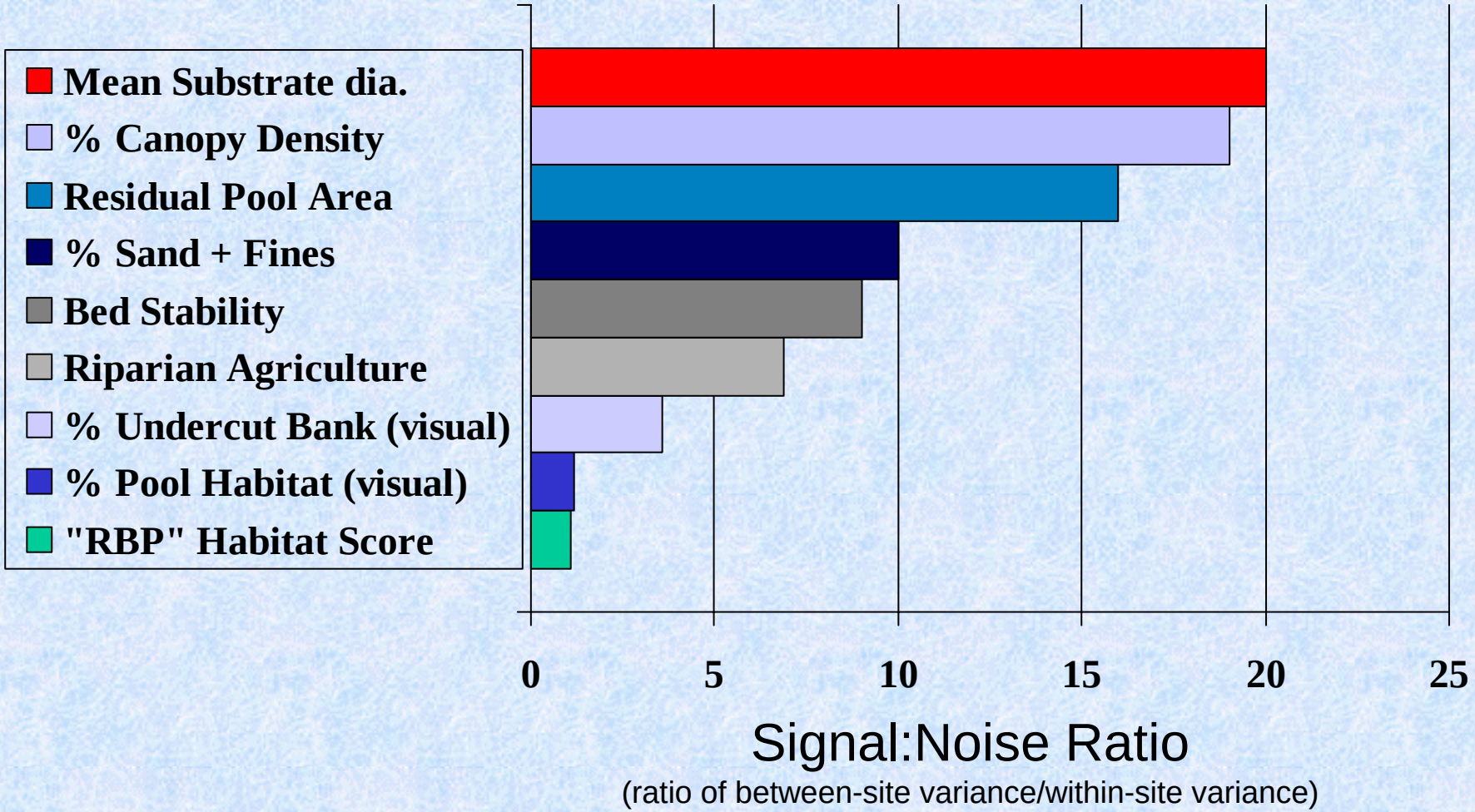
Indicator Approach
How do we measure?



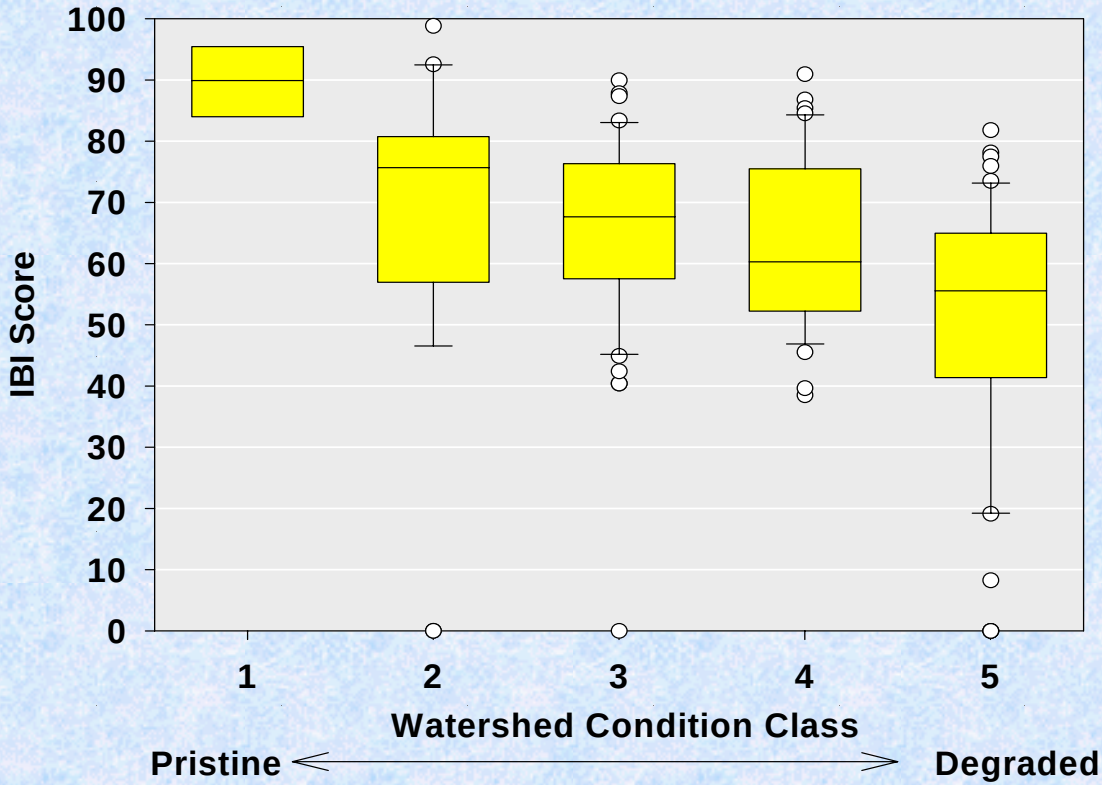
Indicator Approach
How responsive is it?



Indicator Approach
How variable is it?



Indicator Approach
Can we score it?



Watershed Condition Classes from Bryce et al., 1999, JAWRA

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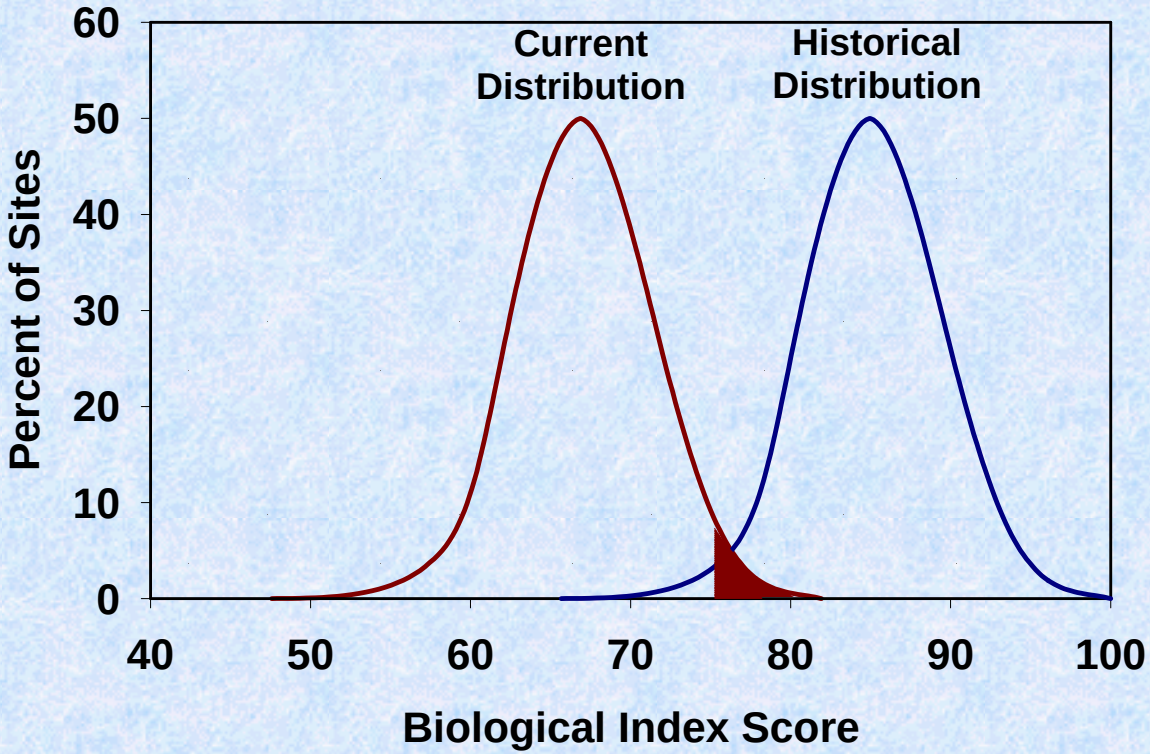
Reference Condition

estimating distribution of sites in reference condition



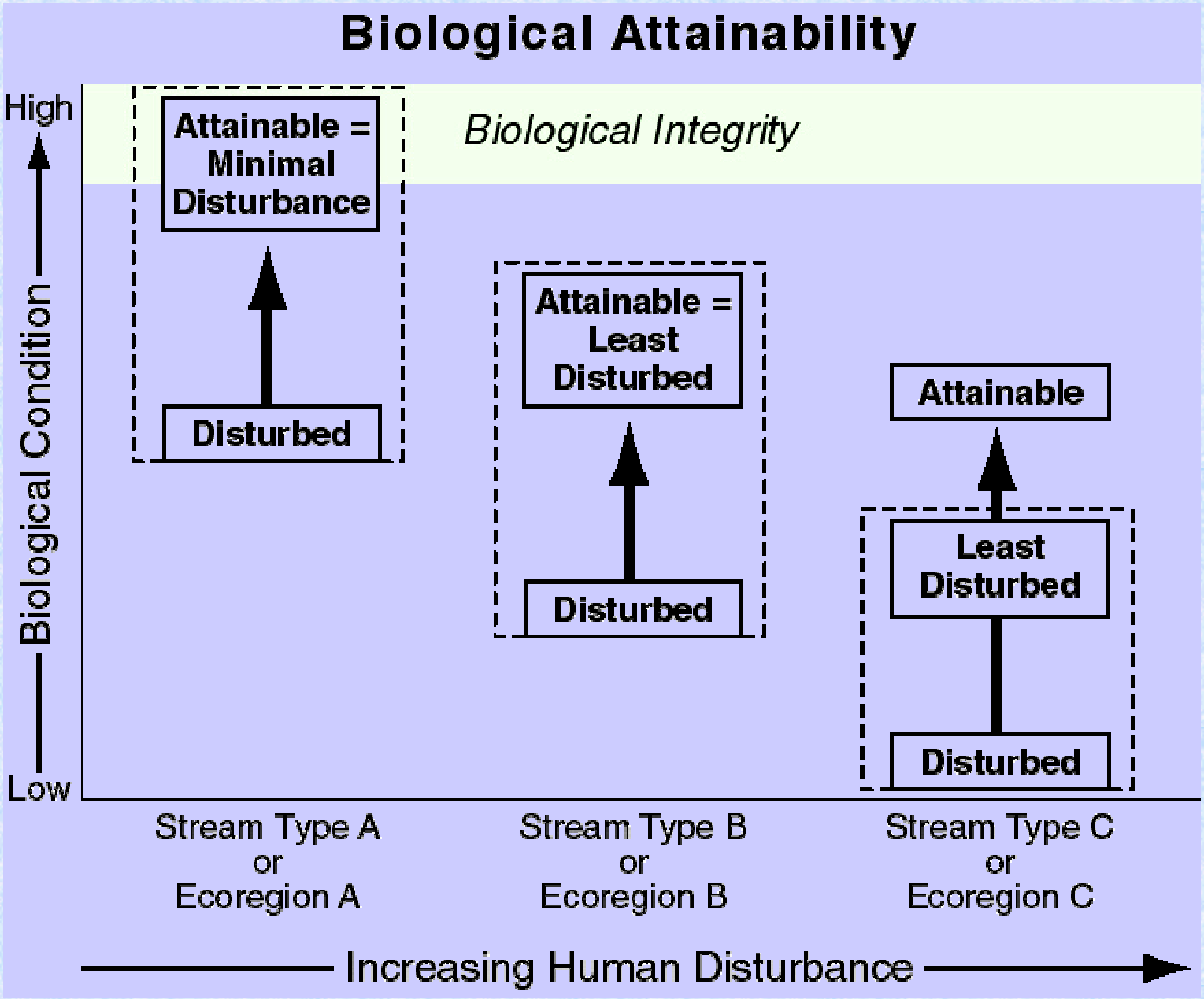
Definitions of Reference Condition

For EMAP-W we recognize that multiple definitions exist, and that these 3 are especially pertinent:

- **Minimally Disturbed Condition** - condition of streams in the absence of significant human disturbance (e.g., "natural," "pristine" or "undisturbed")

- **Least Disturbed Condition** –found in conjunction with the best available physical, chemical and biological habitat conditions given today's state of the landscape - defined by a set of explicit criteria to which all reference sites must adhere

- **Best Attainable Condition** – this condition is equivalent to the ecological condition of (hypothetical) least disturbed sites where the best possible management practices are in use

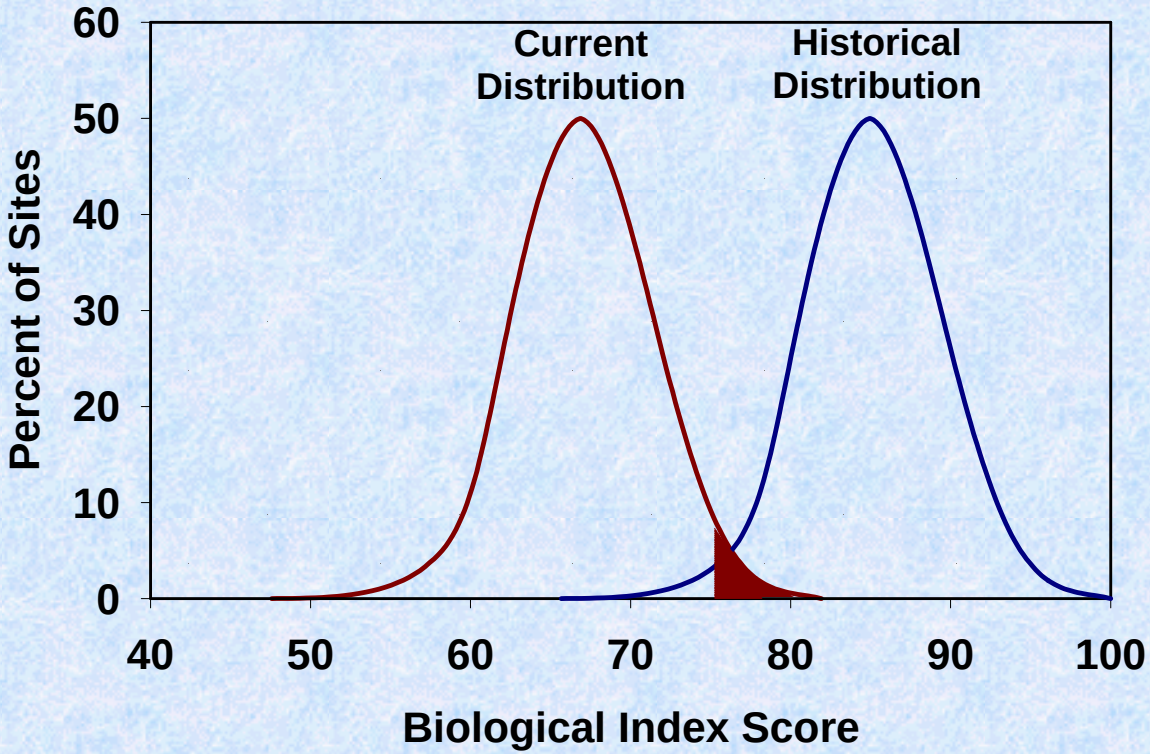

Biological Attainability
High
Biological Condition
Low
Biological Integrity
Attainable = Minimal Disturbance
Disturbed
Attainable = Least Disturbed
Disturbed
Attainable
Least Disturbed
Disturbed
Stream Type A or Ecoregion A
Stream Type B or Ecoregion B
Stream Type C or Ecoregion C
Increasing Human Disturbance

Reference Condition in EMAP-W

- **Goal is to estimate the distribution of indicator values in sites of Least Disturbed Condition** – the best of what's left
- **Estimating the distribution will require a sufficient sample size – minimum of 20 sites/state**
- **Multiple methods for finding sites in Least Disturbed Condition**
  - Best Professional Judgment
  - "filtered" probability sites
  - GIS screening
- All sites (regardless of selection method) will need to meet our definition, i.e., they will need to represent the best of the current distribution

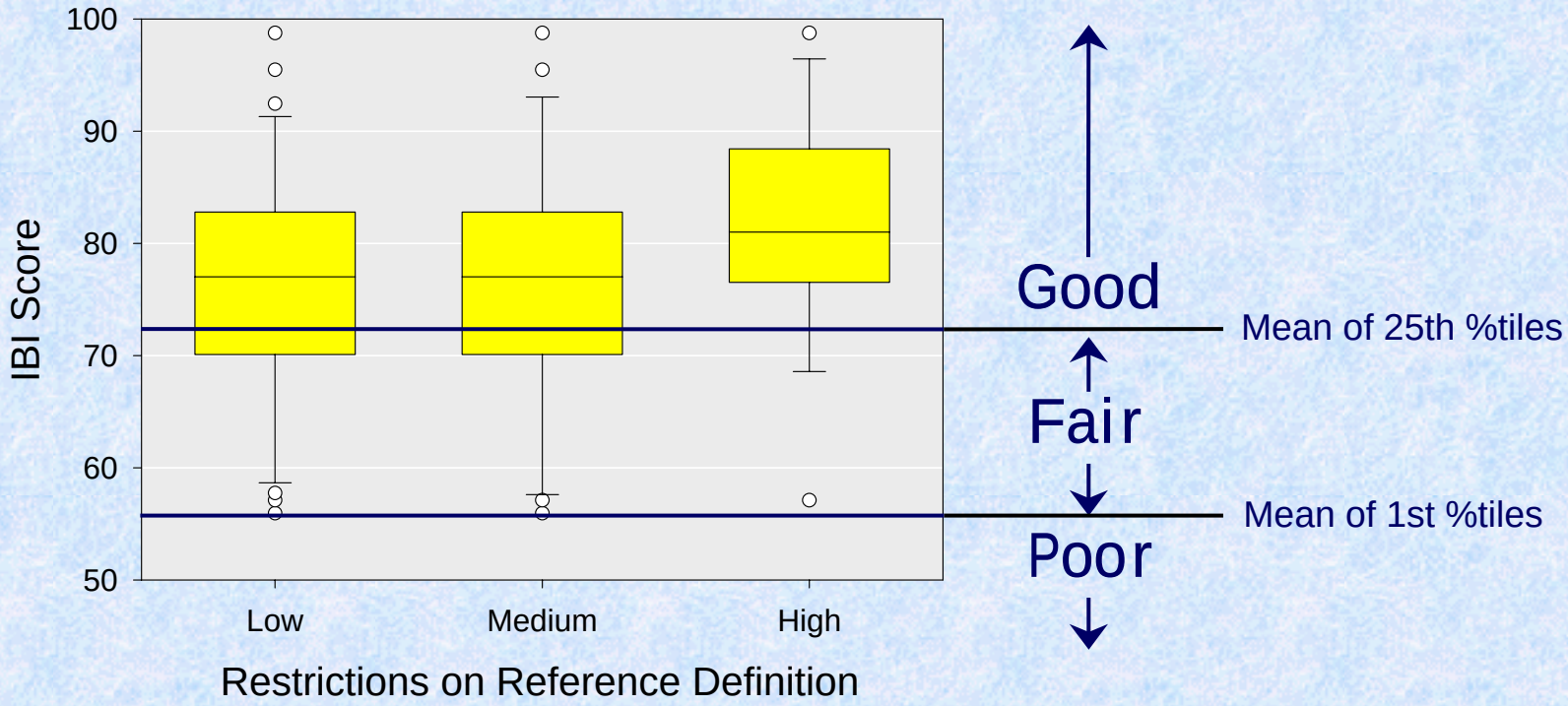
Reference Condition

estimating distribution of sites in reference condition



Reference Condition

Using estimates to set expectations



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What is EMAP West?

A monitoring demonstration of indicators and designs for measuring environmental progress

- unbiased estimates of condition of ecological resources - streams and rivers
- comparative ranking of stressors
- tools for biocriteria
- partnerships between EPA/States/Tribes

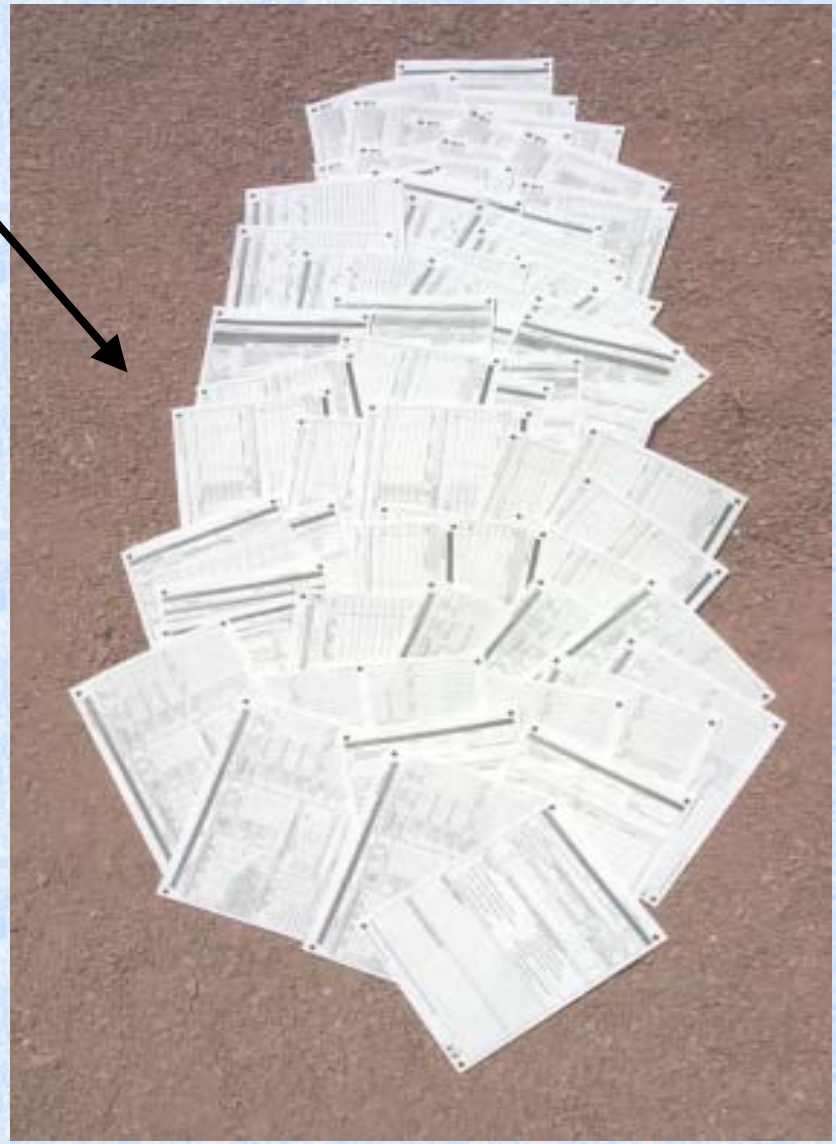
Scope of EMAP West

- More than 300 sites/year
- ~1300 sites over 4 years
  - 11 of 12 States
  - 3 EPA Regions
  - 2 EPA Contractors
- Biological Indicators:
  - Aquatic Vertebrates
  - Macrobenthos
  - Periphyton
- Chemical and Physical Habitat Indicators

Ultimate EMAP-W Goal: Unbiased Regional Assessments

- Field data forms
- Laboratory data
  - Chemistry (EPA-Corvallis)
  - Benthos (EcoAnalysts, CDFG)
  - Vertebrates (Smithsonian)
  - Periphyton (TBD)
  - Fish Tissue (EPA-Corvallis, EPA-Cincinnati)
  - Fish Pathogens (USFWS)
- Watershed stressors and Landscape data
  - EPA-Las Vegas and Corvallis

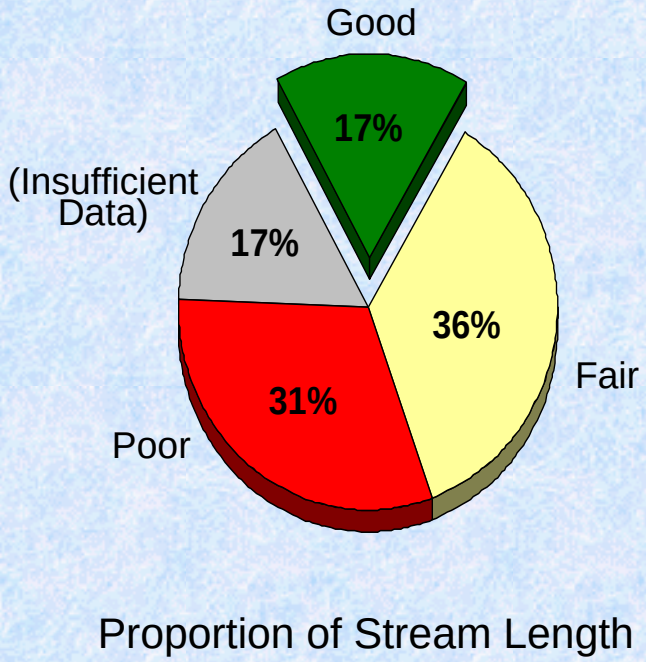
FROM THIS:



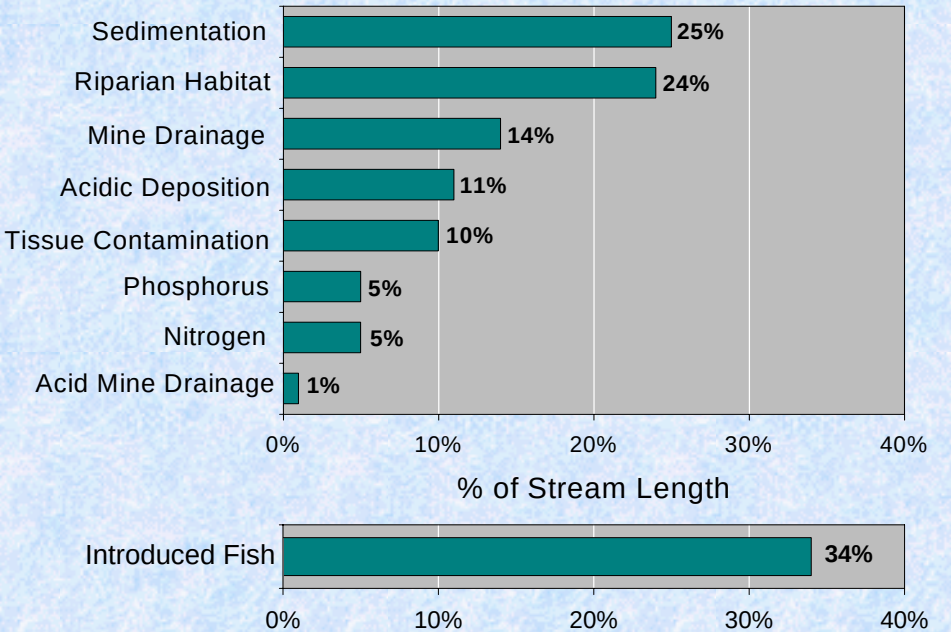
Ultimate EMAP-W Goal: Unbiased Regional Assessments

TO THIS

Fish IBI Results



Ranking of Potential Stressors



(Example from EMAP in Mid-Atlantic)